New technique to facilitate renal revascularization with use of telescoping self-expanding stent grafts: VORTEC

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Abstract: This article describes a new, less invasive prosthetic graft anastomotic technique that uses self-expanding stent grafts that are "telescoped" into aortic branches. This method, the VORTEC (Viabahn Open Revascularization TEChnique), obviates the need for potentially difficult complete vessel exposure and graft anastomoses, thereby reducing the duration of flow interruption and simplifying the performance of complex aortic reconstructions and so-called debranching procedures requiring reconstruction of major branches such as renal arteries. Minimal exposure of one surface of the renal artery allowed introduction and deployment of a self-expanding Viabahn (W.L. Gore Associates, Flagstaff, AZ) device using the Seldinger technique. The Viabahn devices used were 5 to 8 mm in diameter and 5 to 15 cm in length depending on individual anatomy (assessed by preoperative computed tomographic angiography). Overall, 82 renal arteries have been revascularized in 58 patients using the VORTEC. The technical success rate was 100%, with all of the stent grafts implanted as intended with maintenance of flow. The patency rates were 97% after 30 days and 96% after a mean follow-up of 18 months (range 1-38 months). The VORTEC allows performance of safe and expeditious revascularization of renal arteries. This new technique may represent significant improvement over the standard approach of surgical exposure and sutured anastomosis.

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ORIGINAL ARTICLE

New Technique to Facilitate Renal Revascularization with Use of Telescoping Self-Expanding Stent Grafts: VORTEC

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This article describes a new, less invasive prosthetic graft anastomotic technique that uses self-expanding stent grafts that are ''telescoped'' into aortic branches. This method, the VORTEC (Viabahn Open Revascularization TEChnique), obviates the need for potentially difficult complete vessel exposure and graft anastomoses, thereby reducing the duration of flow interruption and simplifying the performance of complex aortic reconstructions and so-called debranching procedures requiring reconstruction of major branches such as renal arteries. Minimal exposure of one surface of the renal artery allowed introduction and deployment of a self-expanding Viabahn (W.L. Gore & Associates, Flagstaff, AZ) device using the Seldinger technique. The Viabahn devices used were 5 to 8 mm in diameter and 5 to 15 cm in length depending on individual anatomy (assessed by preoperative computed tomographic angiography). Overall, 82 renal arteries have been revascularized in 58 patients using the VORTEC. The technical success rate was 100%, with all of the stent grafts implanted as intended with maintenance of flow. The patency rates were 97% after 30 days and 96% after a mean follow-up of 18 months (range 1–38 months). The VORTEC allows performance of safe and expeditious revascularization of renal arteries. This new technique may represent significant improvement over the standard approach of surgical exposure and sutured anastomosis.

Key words: *nonsuture anastomosis, Hybride procedure, pararenal or thoracoabdominal aneurysm, renal artery revascularization, stent graft anastomosis, visceral debranching*

Standard anastomotic technique requires extensive exposure, circumferential dissection, and occlusion of vessels. Performance of the anastomosis can be difficult and time-consuming, leading to prolonged flow interruption and organ ischemia. This standard anastomotic technique was originally described by Alexis Carrel in 1902.[1] Although a number of improvements and modifications followed,[2] none were truly advantageous. The need for a better solution that minimizes dissection, exposure, and vessel occlusion is obvious. We describe herein a new technique (Viabahn Open Revascularization TEChnique [VORTEC]) that requires only minimal vessel exposure, obviates the need for vessel cross-clamping or anastomotic suturing, and reduces significantly the duration of blood flow interruption.

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Material and Methods

From January 2004 to December 2007, the VORTEC was used in 58 patients with abdominal or thoracoabdominal aortic aneurysms requiring intra-abdominal debranching and extra-anatomic revascularization of one or both renal arteries before simultaneous or stepped exclusion of the aneurysm. Computed tomographic angiography (CTA) was obtained in all cases to delineate renal artery anatomy, to measure vessel lengths and diameters, and to identify possible severe renal artery stenosis that might require adjunctive endarterectomy (Figure 1). A 5 or 6 mm in diameter Viabahn graft (5, 10, or 15 cm in length; Gore & Associates, Flagstaff, AZ) was used in all cases, representing approximately 10% oversizing. Overall, 82 renal arteries were revascularized using the VORTEC.

To perform VORTEC, the origin of the renal artery was identified and only 1 cm of the anterior wall was exposed. After puncturing the arterial wall, the Viabahn device was

Figure 1. Preoperative measurement on computed tomographic angiography. *A*, Right side. *B*, Left side. In this case, 6 mm Viabahn stent grafts were used on both sides.

introduced over a guidewire using the Seldinger technique. After the stent graft was deployed partly within the artery and partly projecting outside the artery, the graft was balloon dilated and two polypropylene 6.0 sutures were placed to fix the stent graft within the renal artery. At the beginning of our experience, the proximal end of the stent graft outside the renal artery was sutured end to side directly to the main graft, bypassing the aneurysm (Figure 2), or to an aortic graft.[3] The technique then evolved to the use of an interposition branch graft on the main bypass graft (Figure 3) or aortic graft, allowing for the reestablishment of renal blood flow within a few minutes since no sutured stent graft to graft anastomosis was required. Finally, the proximal stump of the renal artery was ligated to avoid backflow into the aneurysm.

Early postoperative anticoagulation consisted of heparin with aspirin. Long-term therapy included warfarin combined with aspirin or dual-antiplatelet therapy with aspirin and clopidogrel. Duplex ultrasonography was performed directly postoperatively. CTA and clinical follow-up were obtained at 6 weeks and 3, 6, and 12 months after the procedure (Figure 4) and then on an annual basis.

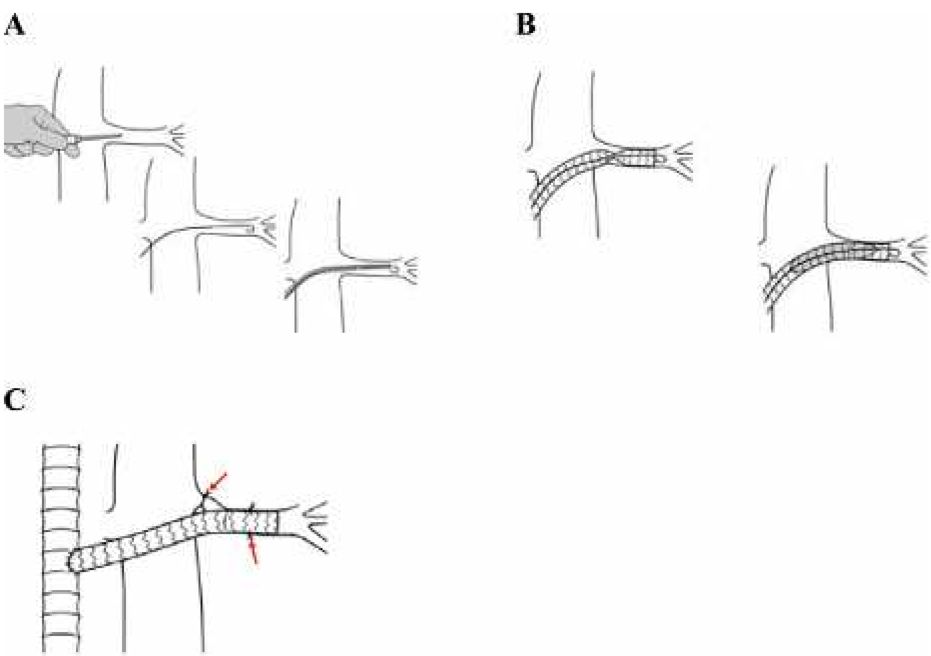

Figure 2. The VORTEC procedure. *A*, Puncture of the renal artery followed by placement of a 0.35-inch guidewire and introduction of the Viabahn stent graft. *B*, The stent graft is deployed and the balloon dilated to achieve full deployment at the entry site into the renal artery. *C*, The stent graft is then anastomosed to the bypass graft. Two stitches are placed on the renal artery to fix the Viabahn stent graft to the artery wall. Finally, the trunk of the renal artery is interrupted to avoid backflow into the excluded aorta or aneurysm.

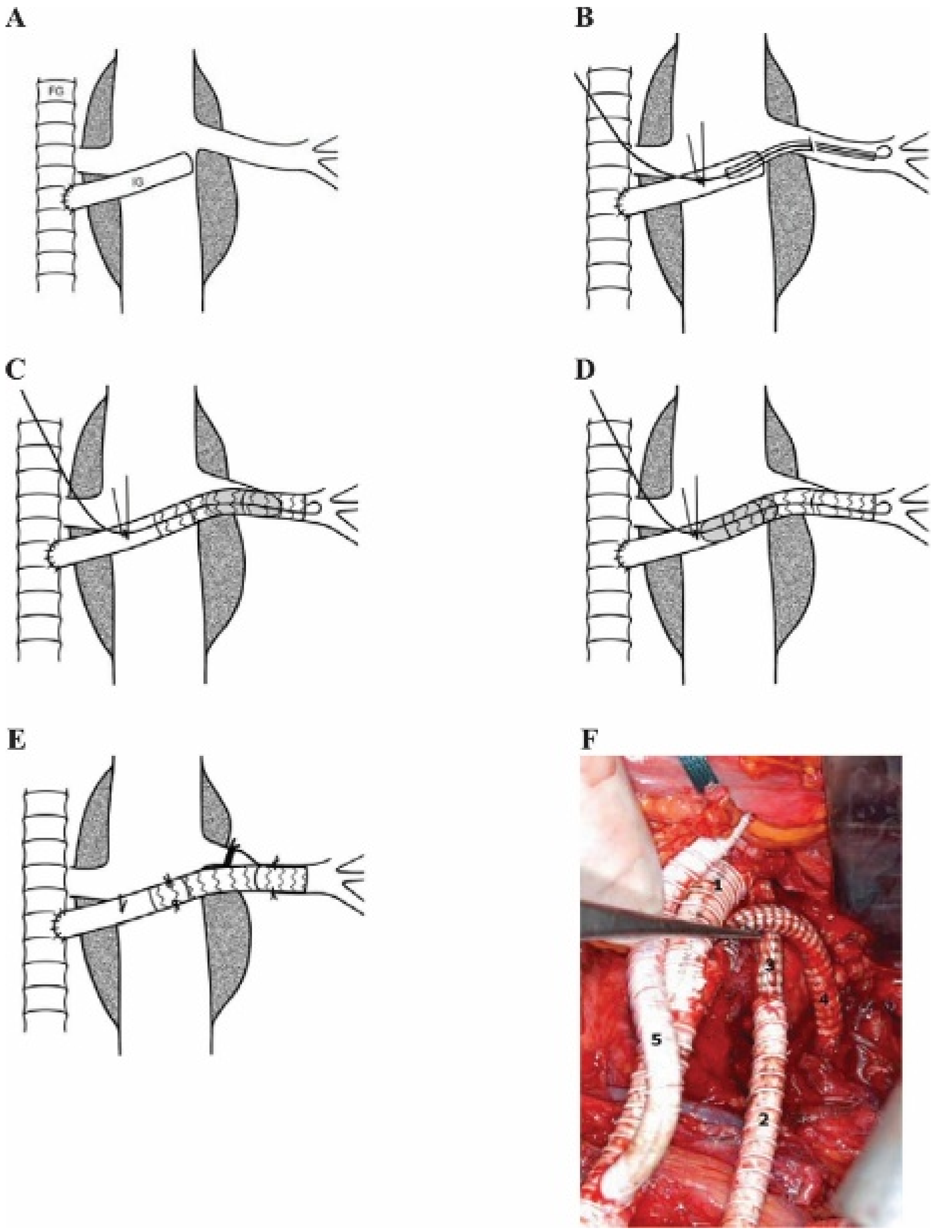

Figure 3. The VORTEC with interposition graft (IG). *A*, The IG is anastomosed to the bypass graft (feeding graft [FG]). The FG chosen is smaller than the Viabahn stent graft. For example, a 6 mm Viabahn stent graft will land into a 5 mm FG. *B*, The guidewire and the Viabahn stent graft are introduced through the IG and the renal artery. A purse-string suture is preplaced at the puncture site on the IG. After deployment of the stent graft, balloon dilation is performed (*C*), followed by balloon dilation of the IG (*D*). *E*, Flow is restored after having tied the purse-string suture on the IG. The stent graft is fixed to the renal artery and IG with 6.0.polypropylene stitches. Finally, the proximal renal artery is interrupted with a silk ligature. *F*, VORTEC with/without IG. 1 = bypass graft (FG) from the right common iliac artery to the superior mesenteric artery; 2 = interposition graft; 3 = Viabahn stent graft from the IG to the right renal artery; 4 = Viabahn stent graft from the FG to the left renal artery; 5 = bypass graft from the FG to the celiac trunk.

Results

The technical success rate was 100%. The mean renal ischemia time was 11 ± 8 minutes (range 2–35 minutes). The primary patency rate was 94%, with occlusion occurring in 5 of 82 arteries. The assisted primary patency rate was 97% (80 of 82) as two occluded Viabahn grafts could be reopened by endovascular means: selective thrombolysis and thromboaspiration in two and redo of a proximal Viabahn anastomosis in another. During a mean follow-up of 18 months (range 1–38 months), the overall patency rate was 96%. No patient required hemodialysis.

Discussion

The Viabahn device is a relatively low-profile, flexible stent graft that was developed for endovascular treatment of femoropopliteal arterial occlusive disease and peripheral aneurysms.[4,5] Its construction is a composite based on the combination of a thin expanded polytetrafluoroethylene (ePTFE) (GORE-TEX, W.L. Gore & Associates) lining and a surrounding self-expanding nitinol stent. GORE-TEX ePTFE is a well-known synthetic material with a long and successful record in traditional and endovascular surgery. Its biocompatibility is well established, and its potential thrombogenicity—although real—was most recently

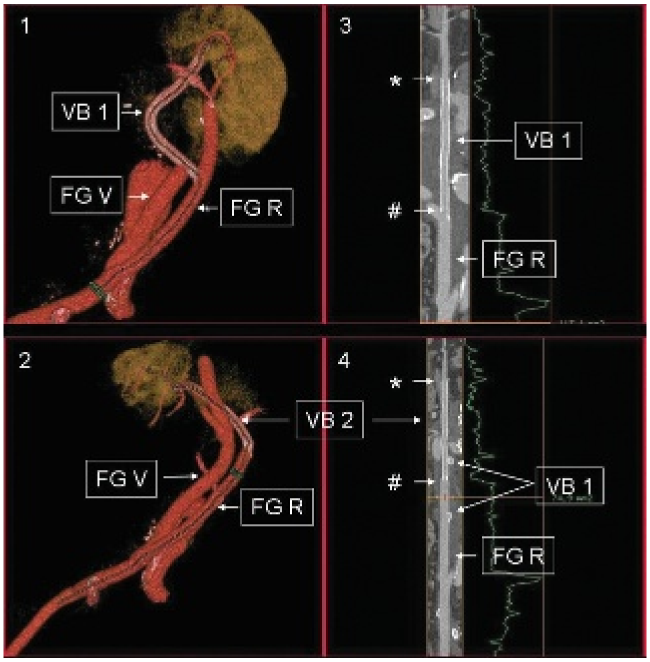

Figure 4. Computed tomographic (CT) scan after 12 months of follow-up. CT reconstruction shows the Viabahn stent graft and the native renal artery. There is no stenosis or myointimal narrowing.

decreased by the addition of a heparin coating (Propaten) on the inner surface. The nitinol stent frame is located on the outer surface of the plastic, so its behavior is quite similar to that of a conventional GORE-TEX vascular graft. Available diameters and lengths range from 5 to 8 mm and 2.5 to 15 cm, respectively. Introducer size ranges from 7F (for 5 and 6 mm diameter stent grafts) to 8F (for 7 and 8 mm devices). During open surgical procedures, it can be implanted in much the same way as percutaneously, with the only (positive) difference being that the target artery is directly visible. Implantation through a sheath is quite easy and atraumatic. For best results, the procedure should be performed under fluoroscopic and angiographic guidance, although this is not necessary with open procedures.

The technique has many advantages. Vessel dissection and exposure are reduced to a minimum (anterior wall only). Vessel cross-clamping is avoided altogether. Blood flow is interrupted only for a short time, significantly reducing ischemia and reperfusion injury. But the technique does have some limitations. Safe anchorage and telescoping of the Viabahn graft require a landing zone length of at least 2 cm. The decision to sacrifice a renal accessory branch should be based on the individual situation. In case of a severely diseased (stenosed) renal artery, endarterectomy should be performed prior to stent graft delivery. As the smallest Viabahn stent graft presently available is 5 mm in diameter, the target vessel must be at least 4.0 mm in diameter. Finally, these devices are expensive.

However, the described technique represents a significant improvement over the traditional vascular anastomotic surgical techniques for renal artery revascularization when an aortic aneurysm involves renal arteries. It could also present advantages in other circumstances, especially when an extra-anatomic debranching procedure is required to enable endovascular graft treatment of extensive pararenal and thoracoabdominal aortic aneurysms. Furthermore, the VORTEC procedure, with the use of telescoping Viabahn self-expanding grafts, can be expanded to other aortic branches, abdominal and thoracic. Further refinements are sure to evolve, resulting in increased applicability of this technique to other arteries in areas of difficult surgical access throughout the body, including visceral arteries and aortic arch branches.[6]

However, as with other new techniques, the questions of reproducibility and long-term results must be answered. Although our early evidence appears to be supportive and positive, it will not be possible to address such concerns for some time. It is hoped that other groups will undertake these pursuits in the near future. A larger clinical experience with longer patient follow-up cohorts will one day provide more definitive supportive evidence. Nonetheless, we feel confident that the early results presented in this article are promising enough to warrant further use and adoption by others.

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